Hadro-chemical freeze-out at RHIC

M. Kaneta, V. Koch, H.G. Ritter, and N. Xu

At lower bombarding energies, most of the particle production have been analyzed within the framework of statistical models[1] These approaches are applied to the results of both elementary collisions[2] ($e^+ + e^-/p + p/\overline{p} + p$) and heavy ion collisions[2] ($Au+Au/Pb+Pb$). While many features of the data indeed imply that a high degree of chemical equilibration is reached both at AGS and SPS energies, the three most important results are: (i) at high energy collisions, the chemical freeze-out (when the inelastic collisions ceases) occurs at about 160-180 MeV and it is 'universal' to both elementary and heavy ion collisions; (ii) the kinetic freeze-out (when elastic scatterings cease) occurs at a lower temperature $\sim 120 - 140$ MeV; (iii) the compilation of freeze-out parameters in heavy ion collisions in the energy range from 1 - 200 AGeV shows that a constant energy per particle $\langle E\rangle/\langle N\rangle \sim 1$ GeV can reproduce the behavior in the temperature-potential ($T_{ch} - \mu$) plane.

In order to study the hadro-chemical properties for collisions at RHIC energy, we performed the thermal fit to the measured particle ratios and the results are shown in Figure 1. The chemical temperature parameter and baryonic potential are $T_{ch} = 170 \pm 5$ MeV and $\mu_B = 40 \pm 5$ MeV, respectively. A value of $\varepsilon_{weak} = 50$ % for the efficiency of reconstructing weak decay is assumed. Number of pion is strongly affected by the ε_{weak} and so is the T_{ch}. From the figure one can see that the anti-particle over particle ratios are well reproduced by the fitting. On the other hand, unlike particle ratios, especially the multi-strange over pion ratios show a deviation from data. In general, the thermal model values are too small compared with the experimental results.

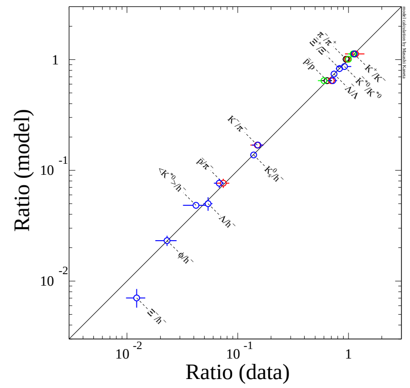

Figure 1: *Thermal fit of the particle ratios as a function of the measured particle ratios. Note that the measured data are mid-rapidity only and has not extraplated to 4π.*

Although the 'bulk' property of the system appears to be in equilibrium, rarely produced particles like multi-strange baryons are not necessarily be in equilibrium within a same volume/time. This might be the source for the observed disfferences. Therefore the multi-strange baryons (and may also be true for those charmed particles: D-meson, J/ψ, and ψ') are *NOT* born in equilibrium with other ligher particles and they should be more informative about the early stage dynamical evolution.

The strangeness saturation parameter γ_s is found to be unity only in central collisions. For non-central collisions the values are very close to the central value from Pb+Pb collisions at SPS energy[3].

Footnotes and References

[1] J. Cleymans and K. Redlich, Phys. Rev. Lett. **81**, 5284(1998); P. Braum-Munzinger, J. Stachel, J. Wessels, and N. Xu, Phys. Lett. **B344**, 43(1995); Phys. Lett. **B365**, 1(1996); P. Braum-Munzinger, I. Heppe, and J. Stachel, Phys. Lett. **B465**, 15(1999).

[2] F. Becattini, Z. Phys. **C69**, 485(1996); F. Becattini and U. Heinz, Z. Phys. **C76**, 269(1997).

[3] M. Kaneta, talk in Workshop on Thermalization and Chemical Equilibration in Heavy Ions Collisiosns at RHIC, http://www.star.bnl.gov/thermalfest/talks/M-Kaneta.pdf, 20 Jul. 2001.; B. Kämpfer et al, hep-ph/0202134, 14 Feb. 2002.